# Improving the Asphalt Materials Acceptance Process

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## Problem Statement

The South Carolina Department of Transportation's (SCDOT) mission states that "the department shall have as its functions and purposes the systematic planning, construction, maintenance, and operation of the state highway system and the development of a statewide intermodal and freight system that is consistent with the needs and desires of the public."[1] In order to ensure state and federal funding is being used adequately, a core function of the construction link of this mission statement must be to provide oversight and inspection of these construction projects. To provide such inspection services, the SCDOT relies not just on its internal inspector staff, but the staff of qualified private consultant firms.

Risk assessment and mitigation is a key component of the 2012-2015 Strategic Management Plan for the SCDOT and identifies several risks that affect the inspection and acceptance of Hot Mix Asphalt (HMA). The first risk component deals with loss of federal transportation funds caused by non-compliance with MAP-21 and other requirements. Federal regulation 23 CFR 637 states that each state transportation department's quality assurance program includes; a policy to assure that materials incorporated into each federal-aid project are in conformity with approved specifications, an independent assurance (IA) program to oversee procedures are performed by qualified testing personnel, and a verification program to be performed by state transportation department personnel that will validate the quality of the product being tested.

The purpose of this project is to examine the current means of acceptance for HMA as directed by the technical specifications, such as SC-M-400, and determine if the process can be improved to meet the requirements as directed by state and federal

guidelines. "Process improvement is a way to look at the world that allows you to do things better, cheaper or faster. By using the ideas behind process improvement, you can create products or services that are vastly superior to your competition. This advantage allows you to create a large and loyal group of customers that will last at least until someone else comes up with a better product than yours." [2]

By examining current methodologies for compliance with specifications and guidelines, this project will attempt to improve the process as it compares not only the requirements needed for acceptance but also the staffing levels on a district and a statewide level to optimum current resources.

## Data Collection

In the late 1980's, the Federal Highway Administration (FHWA), with some influence from industry, began working with state agencies to move from a method-based specification to more of a statistical-based specification. This movement was to improve the contractor's quality control process which would decrease the risk of a state agency to accept inferior material. As a result, SCDOT sponsored **Research Project No. 546, *The Investigation of Contractor Quality Control and End Result Acceptance Specification of Bituminous Paving Mixtures for South Carolina.*** The report, submitted by James A Scherocman and Harold Von Quintas, was completed in March 1993 stated that if a statistically based specification was to be implemented in South Carolina, it must:

- Gain full support from the Department's upper level management,
- Include industry in the development and implementation of the program,
- Ensure the Department and industry jointly prepares a plan of implementation and clearly defined each party's responsibilities.

Upon receipt and review of SPR 546, the Department initiated a follow-up project, ***Research Project No. 563, Evaluation of Quality Assurance Programs for Bituminous Paving Mixtures***, to review and document existing programs, interview FHWA and SCDOT personnel to establish the objectives, survey other State Agencies and analyze historical data of each program.

James L. Burati, Jr., William C. Bridges and Stephen A. Ackerman recommended that the Record Sample, currently referred to as Independent Assurance (IA), and Split Sample programs be maintained with some modifications. These modifications should include the use of independently obtained samples for the Record Sample program and slight modification to the allowable tolerances of both programs.

In March 1995, the Department obtained the services from Dr. James L. Burati again to conduct a follow up research project, ***Research Project No 572, Development of a Quality Assurance Program for Asphalt Paving Mixtures in South Carolina***. As suggested in SPR 546, a joint committee of Departmental and Industry personnel was assembled to oversee the development of the asphalt QC/QA program. The committee met several times over a course of 5 years and after several pilot projects that used both Percent Within Limits (PWL) and Absolute Average Deviation (AAD), the project concluded with a modified PWL specification and was implemented as a full specification in March 2000, which is attached in the appendix.

In a simultaneous effort with Research Project No. 572, and as a response to a performance audit conducted in 1997 by KPMG Peat Marwich, LLP, Dr. Serji Armikhanian of Clemson University developed a certification program that would

include the certification of both Departmental and industry personnel to ensure all asphalt inspectors are both fair and consistent with following specifications and procedures.

With the development of the PWL specification, each District within the SCDOT developed its own District Asphalt Managers (DAM) position description, with the assistance of the Director of Construction's staff, to be able to meet the needs of the department. At a minimum, the DAM position would involve:

- Visiting HMA plant sites as the hot mix was being produced,
- Observing the required testing performed by the contractor,
- Ensuring the QC testing was performed,
- Examining control charts for variability,
- Reviewing submitted data for accuracy, and
- Providing guidance to the Resident Engineer on payment.

In July 2007, the FHWA conducted a Materials Quality Assurance (QA) stewardship review. The objective of this assessment was to review the "program practices and procedures to assess compliance with current federal regulations, specifically 23 CFR 637, and to ascertain the status of the State's implementation of the QA regulation."[3] The review consisted of meetings with SCDOT Office of Materials and Research (OMR) staff, review of project files in three various districts around the state as well as interviews with current District Asphalt Managers.

After completion of the audit, the FHWA representatives determined that the current process of "validation of contractor test results is inadequate and does not comply with the requirements of Title 23 Code of Federal Regulations, Part 637 (23CFR637)." The report also stated that "the SCDOT's current use of split samples verification only

assesses testing variability and there is no verification testing of volumetric properties of the mix or density of the pavement." [4] To ensure compliance, the SCDOT must address:

- Observation of test procedures alone is not sufficient for verification of properties that are used for pay. It was also observed that due to time restraints little observation was occurring especially in the area of density cores. There needs to be verification testing of the voids properties of the mix and density of asphalt pavements.
- All verification testing needs to be performed on samples that are taken by the SCDOT personnel or their representatives, independent of the contractor samples and remain in custody of SCDOT personnel all of which will require additional resources.
- The State needs to revise the method of validating the contractor's test results to use pooled data from the current one on one comparison of test results.
- All QC and all independent verification sampling and testing must be random.

The audit report concluded with an opportunity for improvement section and stated that "the State's current process has the District Asphalt Manager spending a large portion of their time performing administrative tasks. The State's process should be reviewed and revised to allow the DAMs to better monitor plant and field operations."

## Data Analysis

The Office of Materials and Research held numerous meetings with the DAMs and their supervisors over the course of five years to explain the importance of monitoring plant and field operations due to findings of the July 2007 audit. These meetings included a background of changes that would be made to the entire process as well as ways the district could improve monitoring of plant testing and increase consistency within the state. One such way was to utilize the Asphalt Field Lab Checklist, appendix A, in each district. This checklist would guide the technician through a typical inspection and assist in documenting specific events that could be used

to determine if further visits were needed. This checklist would be completed and then forwarded to the Asphalt Materials Engineer and the Resident Engineer, who could utilize the information to determine if problems were occurring and if the problems were isolated to a particular plant or was occurring statewide.

In addition to reviewing checklists submitted from random projects, a survey was distributed to each DAM in order to gain a better understanding of their time management and determine how many employees each DAM office has as well as how each employee spends a typical day. This information, Chart A-1, shows the number of staff members each district employs as well as how much time, Chart A-2, each manager and their staff spends per week visiting a plant to observe testing. With the addition of other duties required as a direct or indirect responsibility of the position description that the employees are responsible for, there is limited time the staff has to actually visit each active HMA plant and fully observe the testing needed to ensure proper procedures are being used. Below is a list of some other duties, as indicated in the survey.

- weighing the transporting roadway cores,
- entering sample data into Site Manager,
- transporting referee samples,
- maintaining job control records for each project,
- attending pre-construction and pre-paving meetings,
- communicating with Resident and District personnel as well as contractors,
- helping other offices within the district, including inspection of bridges.

The survey also included a section that allowed each District Asphalt Manager to give their comments as to ways to improve the process. After review of the comments, one issue was prevalent, the DAMs wanted more control of the when a sample is to be taken which will allow more time to observe the plant inspector performing the testing

procedures as well as yield more time to make other plant operation observations. Such observations would include inspecting stockpiles for contamination, ensuring the hydrated lime system or liquid anti-stripping additives are being used properly, and observing the loader operator is handling the materials so not to cause segregations.

Another process indicator, as it relates to time management, deals with the number of samples that are being obtained and transported to one of the four Office of Materials and Research Laboratories. In some areas of the state, travel time could take an additional two hours that could be used for monitoring local HMA plants. At an average rate of 2,225 HMA quality assurance split samples, based on the past three years, if a process could be utilized to yield the same confidence level and allow fewer trips, this could drastically increase the amount of time of inspection.

Additionally, and as denoted on sampling methodology flowchart, if the Quality Assurance samples, QA Split sample, were to be repurposed to a truly check sample system and only obtained at a minimal rate, the referee sample program could be eliminated. By doing so, when a QA split sample did not compare with the Contractors QA sample, the referee sample would not have to be obtained and taken to a different SCDOT testing laboratory, saving three to four hours of travel time. Since the testing is a function of OMR, the new process would also put the burden of the lab to confirm, within itself, as to whether or not the split sample actually did not occur or if an error occurred with either the sampling, preparation or testing phase of the procedure.

## Implementation Plan

The South Carolina Department of Transportation needs to improve the process of accepting HMA Quality Assurance samples to allow more time for the District Asphalt Managers and their staff to increase monitoring of field and plant operations. In order to do so, while maintaining the same level of confidence, more emphasis should be put on the verification program which is currently being researched by Dr. James Burati with Clemson University. The proposed process modification would begin by eliminating the contractor's Quality Acceptance split sample / referee sample control and replace it with a check sample program. Under this portion of the program, the check sample could be obtained by the DAM or a representative if during the field and plant monitoring process they have reasonable doubt that an error has occurred in the production or testing of material being sent to departmental project.

Secondly, it is recommended that the DAM be allowed to modify the random sampling tonnage, as prescribed in SC-T-101. This will increase the likelihood that the process is indeed true and not being altered based on the known sample tonnage. This would allow the DAM to be present to observe testing of the materials while maintaining some time management of their own to monitor plant and field operations.

Finally, the DAM should be allowed to obtain verification samples for the Department to increase the verification sampling rate to yield at least 1 sample every 1500 tons of produced mixture. With an average verification sampling rate in 2012 of 1 sample for every 1670 tons of paid HMA mixture, Chart A-3, compared to just a year earlier, Chart A-4, where the verification program obtained 1 sample for every 2412 paid

tons, the verification program could be strengthened if additional trained personnel were made available.

It is recommended by the Federal Highway Administration that for every seven to 10 state test results a maximum of 20 to 30 contractor tests[6] be obtained to compute an F and t-tests analysis. This level of sampling is currently being met but only on Federal Aid projects that are of significant tonnage and are within the state's interstate and high volume primary routes. In addition, assistance from Construction, Engineering and Inspection (CE&I) services costing approximately $450,000 per year [7] has been used to maintain this level of verification sampling and testing.

The aforementioned modifications would decrease the sampling of QA split samples, eliminate the need of QA referee samples and increase the manpower needed for obtaining verification samples, while still adhering to the current specified QA sample requirements of 10% of the contractors QA samples, or 1 sample for every 5000 tons, as represented in charts A-3, A-4 and A-5. Such changes would ultimately increase the time available to each DAM to better monitor plant and field operations as prescribed the 2007 Federal Quality Assurance audit.

## Evaluation Method

As with any process change, to do more with less, increase production with the same or fewer personnel, the primary instinct is to resist. Therefore, to ensure a successful plan is implemented for improving the HMA Acceptance process, the following eight steps must occur [5]:

1. Prepare the infrastructure
2. Coordinate with the organization involved in implementation
3. Implement training
4. Install the production solution
5. Covert the data
6. Perform final verification in production
7. Implement new processes and procedures
8. Monitor the solution

There must be a willing district to work with the Research and Materials laboratory personnel to modify their daily routine, a contractor willing to allow a modification of duties as prescribed in the current specifications and continuation of the tracking system used to determine the aforementioned data.

Once a district has been chosen, proper training and an open line of communication must occur. Since the majority of the current inspectors are considered senior level inspectors, the training will be limited and they can concentrate on plant observations as well as how to spot stockpile and other issues. This process should only take a few days to complete but the tracking of whether or not more time is available for plant observations, as required in the FHWA audit report, will take several months to determine.

## Conclusion

Communication is the key for the success of this process change. As Tony Robbins said, "to effectively communicate, we must realize that we are all different in the way we perceive the world and use this understanding as a guide to our communication with others."

Communication has to begin with the Director of Construction, District Engineers, District Asphalt Managers as well as contractors. There has to be an overall understanding that this process change will improve the overall quality of hot mix asphalt by increasing the samples that are taken at random, allowing for more time for the District Asphalt Manager and his staff to monitor plant and field operations ensuring that the Quality Assurance program continues to meet Federal guidelines while increasing the quality of the hot mixed asphalt.

By allowing another trained personnel additional time to observe a process, problematic systems can be isolated and corrected. This will ultimately increase quality as well as production yielding a better overall product for the taxpayers of South Carolina.

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(1) SCDOT Strategic Management Plan 2012-2015 – page 4
(2) Eileen M. Flanigan and Jon Scott, Process Improvement – page 3
(3) Materials Quality Assurance (QA) Stewardship Review of the South Carolina Department of Transportation – page 1
(4) Materials Quality Assurance (QA) Stewardship Review of the South Carolina Department of Transportation – page 7
(5) Tom Mocha, Project Implementation, 2003 – Part 2
(6) Quality Assurance Stewardship Review Summary Report for Fiscal Years 2003 Through 2008 – page 11
(7) SCDOT Contract 1492 – On-Call CEI HMA Verification - S&ME / SCDOT

# APPENDIX

**Asphalt Field Lab Checklist**

File #: ____ Job Mix #: _____ Lot #: ____

Asphalt Contractor: _____ Plant Location: _____

Date: _____ Type of Mix: _____

Contractor Representative: _____

SCDOT Representative: _____

| | |
|---|---|
| | Is there a Certified Level 1 technician present? |
| | Is there a 310 for the mix being produced? |

**Ignition Oven**

| | |
|---|---|
| | Is the correct time and date on the ignition oven / ignition oven printout? |
| | What sample size are they using? |
| | Has a new calibration factor been determined within the last month? Date: Factor: |

**Gyratory Compactor**

| | |
|---|---|
| | Has it been calibrated (pressure, angle, height, and rotation) within the past 6 months? |
| | Are correct number of gyrations being used? |
| | Are pills near room temperature before being weighed? |
| | Do the two bulk specific gravities compare with each other (within ± 0.020)? |

| | Core 1 | Core 2 |
|---|---|---|
| **Dry Weight** | | |
| **Water Weight** | | |
| **SSD Weight** | | |
| **BSG** | | |
| **Contractor BSG** | | |

**Maximum Gravity Equipment**

| | |
|---|---|
| | Are two MSG samples being tested for each sublot (QA)? |
| | What sample size are they using? |
| | Does the vacuum system have at least one flask in line to be used as a water vapor |
| | Is the sample being vacuumed for 15 ± 2 minutes from full vacuum? |
| | Do the two maximum specific gravity values compare with each other (within ± 0.018)? |

**Lime Rate Calibration**

| | |
|---|---|
| | Has the lime system been calibrated within the past week? |
| | Has the lime rate been verified twice throughout the day? AM: PM: |
| | What procedure are they following? |

**Calibration Records**

| | |
|---|---|
| | Are all ignition oven calibrations for individual job mixes posted or filed in the field laboratory? |
| | Are all equipment calibrations up to date? |

**Copy To: DAM**
**Copy To: RCE / Project File**

**Signed:** _____

**Date:** _____

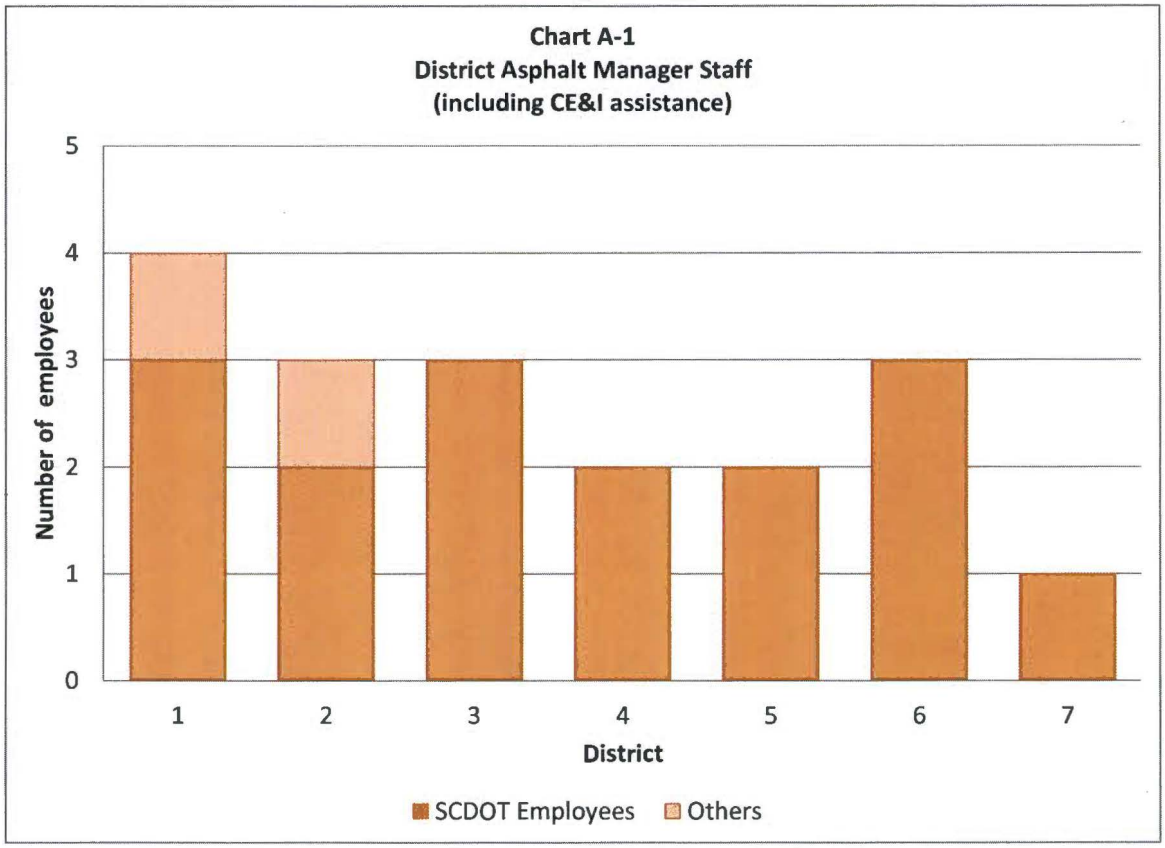


Chart A-1
District Asphalt Manager Staff
(including CE&I assistance)
Number of employees
0
1
2
3
4
5
1
2
3
4
5
6
7
District
SCDOT Employees
Others

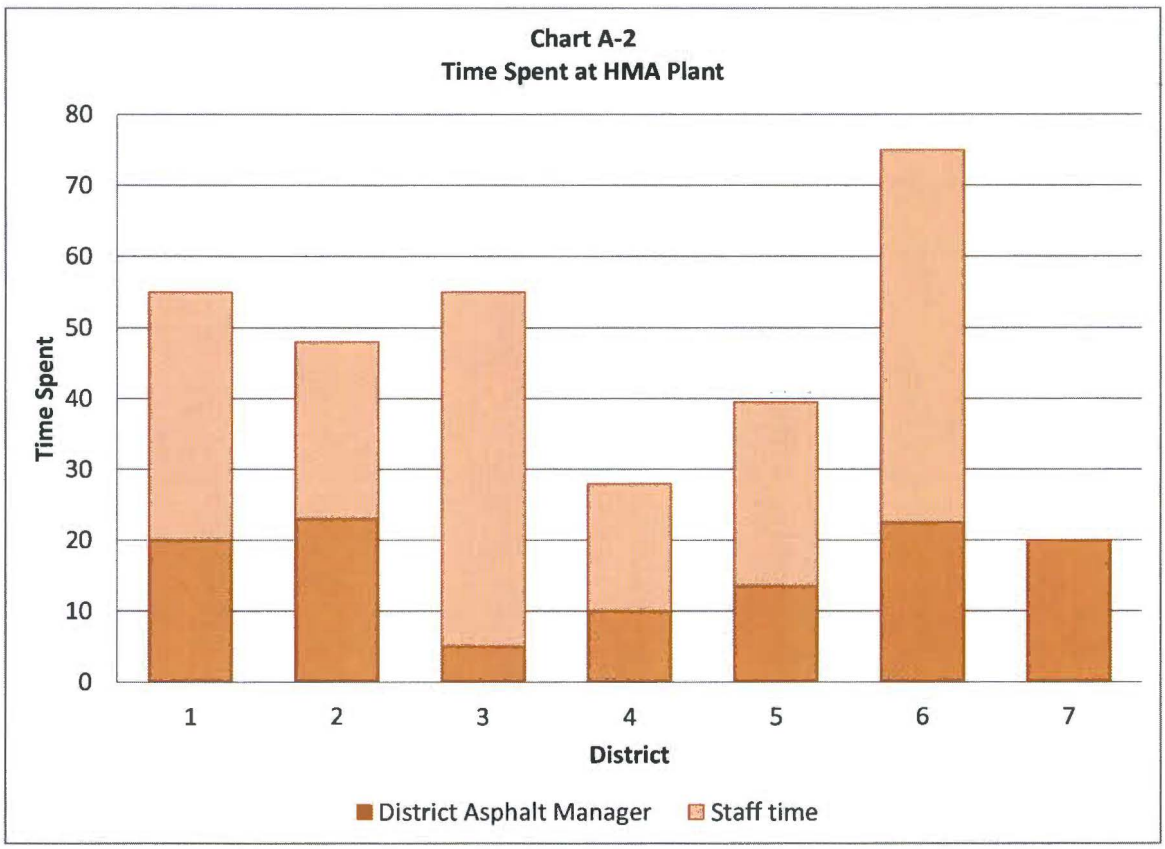
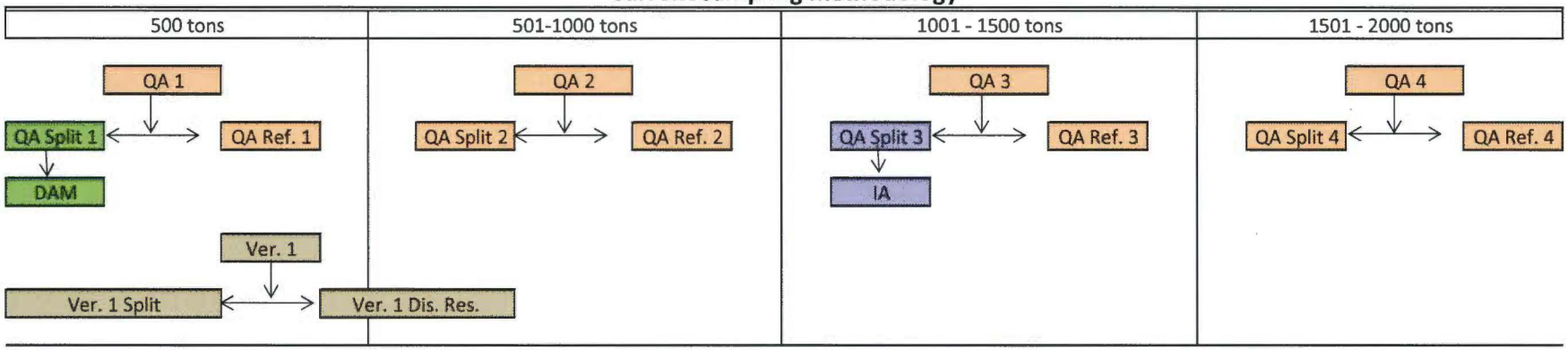
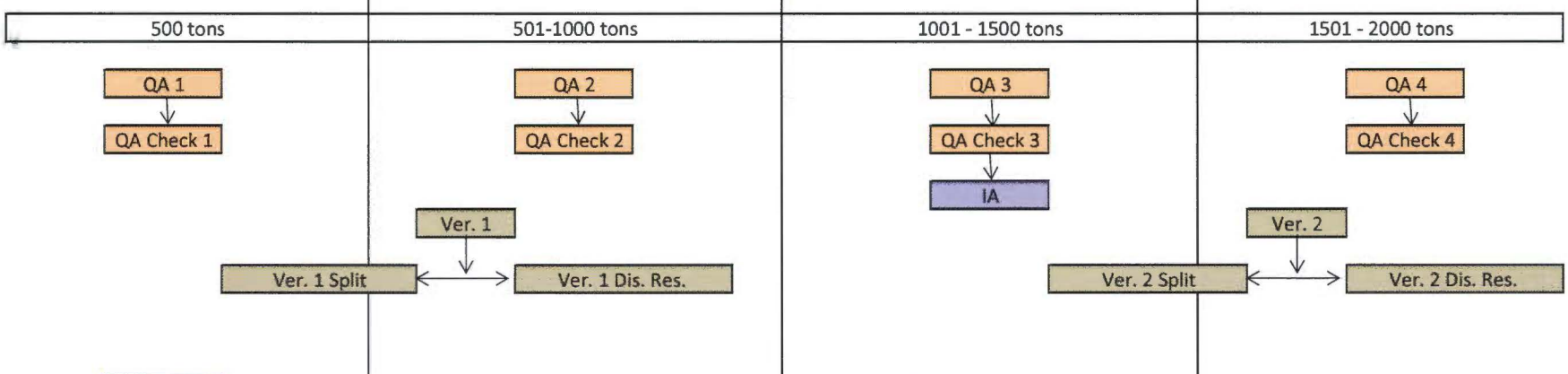


Chart A-2
Time Spent at HMA Plant
Time Spent
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
District
District Asphalt Manager
Staff time

## Current sampling methodology



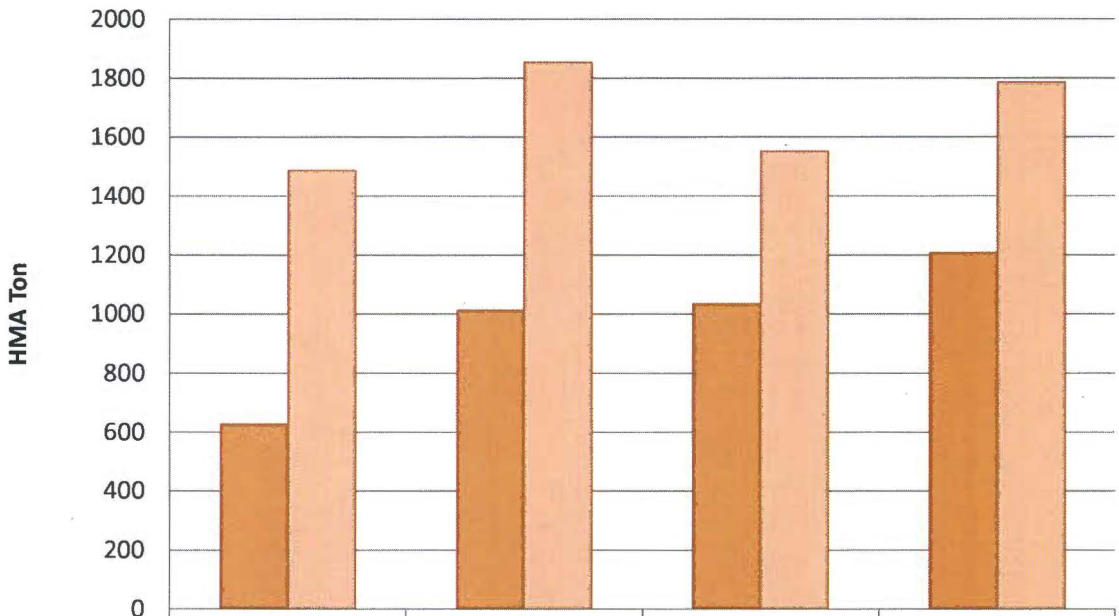

## Proposed modifications to sampling methodology




Notes

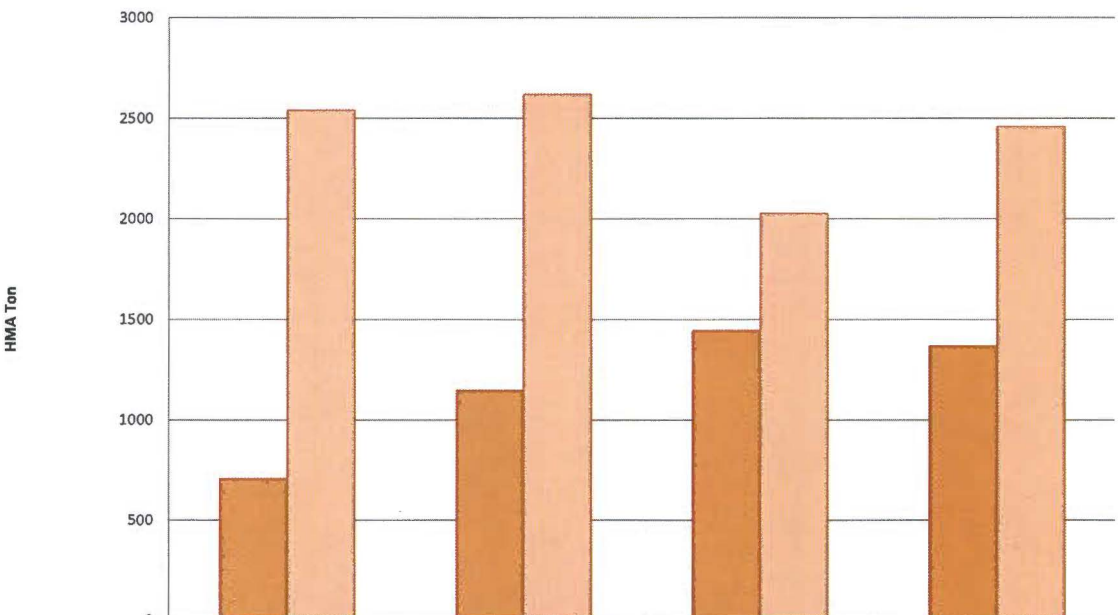
- SCDOT has option of obtaining any or all QA Check samples. Should be sufficient size for "referee" testing.
- DAM will perform more stockpile / plant / cold feed observations
- DAM may assist in obtaining verification samples during plant visits
- Changes with SC T 101 will allow DAM to modify sampling tonnage if needed

## Chart A-3
## Quarterly Samples per Produced HMA Ton - 2012

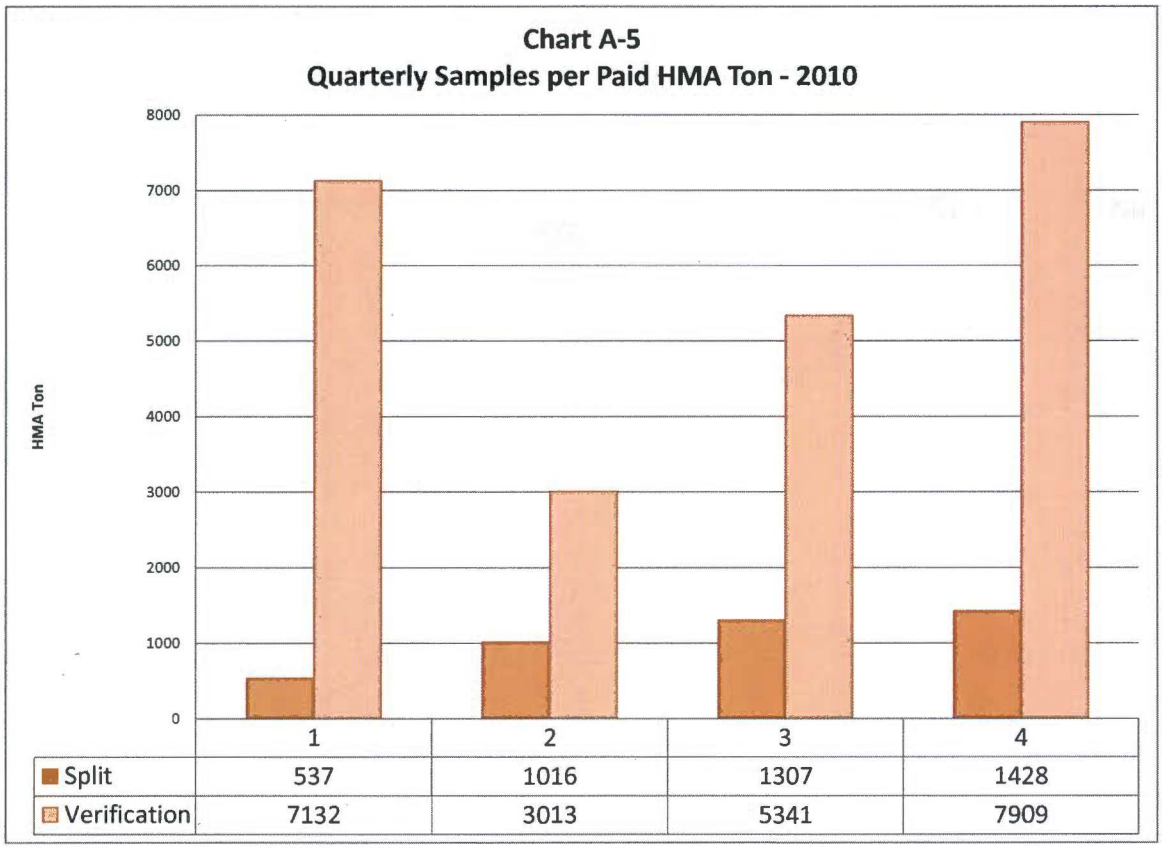



| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Split | 628 | 1013 | 1035 | 1209 |
| Verification | 1488 | 1854 | 1553 | 1787 |

## Chart A-4
## Quarterly Samples per Paid HMA Ton - 2011




| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Split | 708 | 1147 | 1445 | 1368 |
| Verification | 2540 | 2621 | 2027 | 2460 |




| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Split | 537 | 1016 | 1307 | 1428 |
| Verification | 7132 | 3013 | 5341 | 7909 |